

## TOPIC: EXPONENTIAL FUNCTIONS

### Exponential Functions

◆ **Polynomial** functions have a variable base with a number exponent; **exponential** functions have the opposite!

► Exponential functions have a:

- **Base** that is \_\_\_\_\_, \_\_\_\_\_, & 1.
- **Exponent (power)** that contains a \_\_\_\_\_.

| Recall | Polynomial Function | New | Exponential Function              |
|--------|---------------------|-----|-----------------------------------|
|        | $f(x) = x^2$        |     | $f(x) = 2^x$<br>Base: 2, Power: x |

#### EXAMPLE

Determine if each function is an exponential function.

(A)

$$f(x) = \left(\frac{2}{3}\right)^x$$

Exponential function? ☐

Power: \_\_\_\_\_

Base: \_\_\_\_\_

(B)

$$f(y) = 1^y$$

Exponential function? ☐

Power: \_\_\_\_\_

Base: \_\_\_\_\_

(C)

$$f(x) = 10^{x+1}$$

Exponential function? ☐

Power: \_\_\_\_\_

Base: \_\_\_\_\_

◆ You will be asked to evaluate exponential functions for specified values of  $x$ .

► For exponents that cannot easily be done by hand, type **(BASE)** **^** **(POWER)** into a calculator.

#### EXAMPLE

Evaluate the exponential function  $f(x) = 2^x$  for each given value of  $x$ .

(A)

$$x = 4$$

(B)

$$x = -3$$

(C)

$$x = 3.14$$

(D)

$$x = 12$$

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### PRACTICE

Determine if each function is an exponential function.  
If so, identify the power & base, then evaluate for  $x = 4$ .

(A)

$$f(x) = (-2)^x$$

Exponential function? ☐

Power: \_\_\_\_\_

Base: \_\_\_\_\_

$$f(4) = \underline{\hspace{2cm}}$$

(B)

$$f(x) = 3(1.5)^x$$

Exponential function? ☐

Power: \_\_\_\_\_

Base: \_\_\_\_\_

$$f(4) = \underline{\hspace{2cm}}$$

(C)

$$f(x) = \left(\frac{1}{2}\right)^x$$

Exponential function? ☐

Power: \_\_\_\_\_

Base: \_\_\_\_\_

$$f(4) = \underline{\hspace{2cm}}$$

### PRACTICE

Use a calculator to evaluate the following exponential expression. Round to three decimal places.

(A)

$$7^{1.3}$$

(B)

$$3^{\sqrt{6}}$$

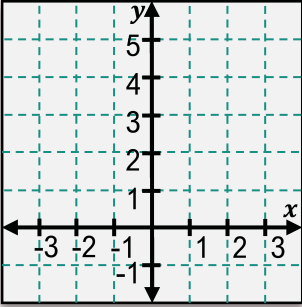
(C)

$$13^\pi$$

## TOPIC: EXPONENTIAL FUNCTIONS

### Graphs of Exponential Functions

◆ Graphs of exponential functions  $f(x) = b^x$  are \_\_\_\_\_ & increase or decrease based on the value of \_\_\_\_.

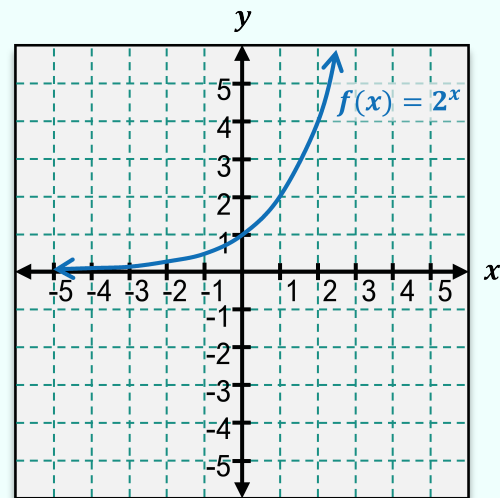
| Properties of $f(x) = b^x$                                                                                                                                                                                                  |                                                                                   |                                                                                        |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| $b > 1$                                                                                                                                                                                                                     |                                                                                   | $0 < b < 1$                                                                            |
| $x$   $f(x) = 2^x$<br>-3<br>-2<br>-1<br><b>0</b><br>1<br>2<br>3                                                                                                                                                             |  | $x$   $f(x) = \left(\frac{1}{2}\right)^x$<br>-3<br>-2<br>-1<br><b>0</b><br>1<br>2<br>3 |
| <b>[ INCREASING   DECREASING ]</b><br>Steeper for _____ $b$                                                                                                                                                                 |                                                                                   | <b>[ INCREASING   DECREASING ]</b><br>Steeper for _____ $b$                            |
| ► <b>y-intercept</b> is always ( __ , __ )<br>► _____ <b>x-intercept</b> ; $x$ -axis ( $y = \underline{\hspace{1cm}}$ ) is an <i>asymptote</i><br>► <b>Domain:</b> _____, ( __ , __ )<br>► <b>Range:</b> _____, ( __ , __ ) |                                                                                   |                                                                                        |

## TOPIC: EXPONENTIAL FUNCTIONS

### EXAMPLE

Graph the exponential function  $g(x) = 2^x - 3$ , then compare to the given graph of  $f(x) = 2^x$ .

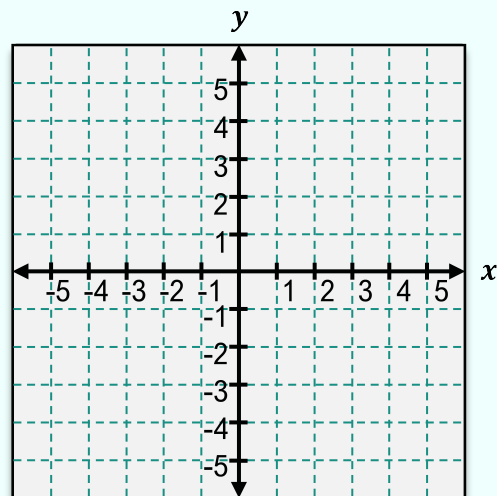
| $x$ | $g(x) = 2^x - 3$ |
|-----|------------------|
| -2  |                  |
| -1  |                  |
| 0   |                  |
| 1   |                  |
| 2   |                  |
| 3   |                  |



### EXAMPLE

Graph the exponential functions  $f(x) = \left(\frac{1}{4}\right)^x$  and  $h(x) = \left(\frac{1}{4}\right)^{x+2}$ . How do the graphs compare?

| $x$ | $f(x) = \left(\frac{1}{4}\right)^x$ | $x$ | $h(x) = \left(\frac{1}{4}\right)^{x+2}$ |
|-----|-------------------------------------|-----|-----------------------------------------|
| -2  |                                     | -3  |                                         |
| -1  |                                     | -2  |                                         |
| 0   |                                     | -1  |                                         |
| 1   |                                     | 0   |                                         |
| 2   |                                     | 1   |                                         |

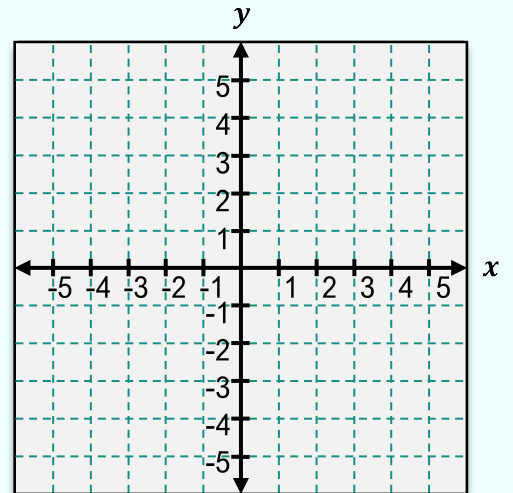


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### EXAMPLE

Graph the exponential function  $f(x) = 3^x$  and  $g(x) = 3^{x-1} + 2$ . How do the graphs compare?

| $x$ | $f(x) = 3^x$ | $x$ | $g(x) = 3^{x-1} + 2$ |
|-----|--------------|-----|----------------------|
| -2  |              | -1  |                      |
| -1  |              | 0   |                      |
| 0   |              | 1   |                      |
| 1   |              | 2   |                      |
| 2   |              | 3   |                      |



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### EXAMPLE

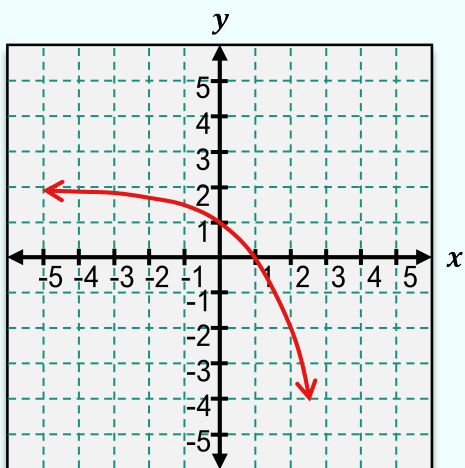
Match each graph to its corresponding exponential function.

(A)  $f(x) = 2^x$

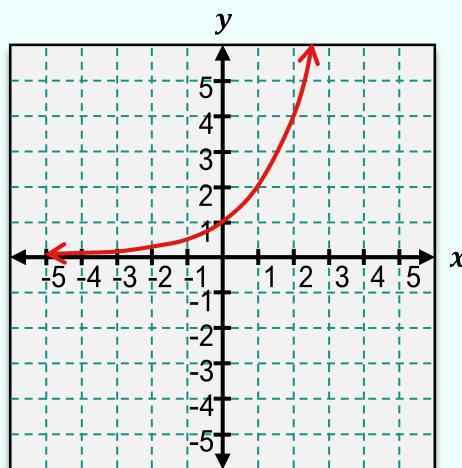
(B)  $f(x) = -2^x + 2$

(C)  $f(x) = 2^{-x}$

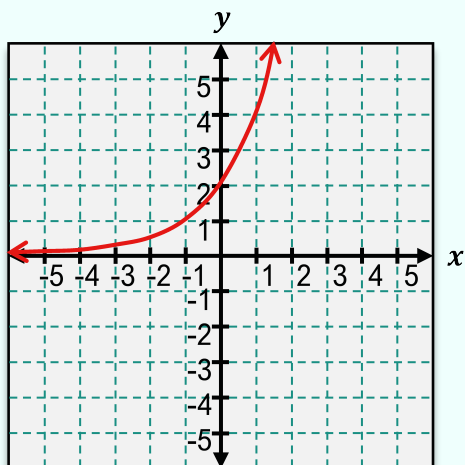
(D)  $f(x) = 2^{x+1}$



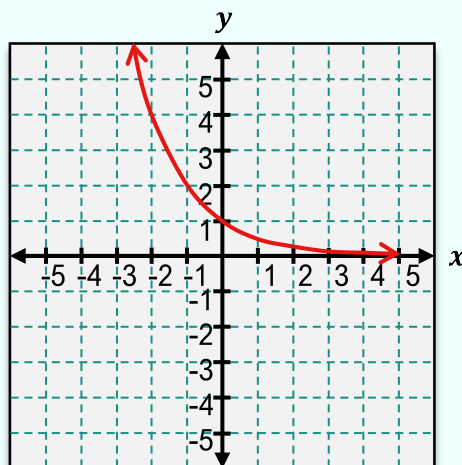
Graph (1): \_\_\_\_



Graph (2): \_\_\_\_



Graph (3): \_\_\_\_



Graph (4): \_\_\_\_

## TOPIC: EXPONENTIAL FUNCTIONS

### CHAPTER RESOURCE: SUMMARY OF EXPONENTIAL FUNCTIONS

#### Characteristics of the Graph of $f(x) = b^x$ , $b > 0$ , $b \neq 1$

- One-to-one function
  - For  $b > 1$ : Increasing and steeper for larger  $b$
  - For  $0 < b < 1$ : Decreasing and steeper for smaller  $b$
- **y-intercept** is always  $(0, 1)$  because  $b^0 = 1$
- **NO y-intercept**,  $x$ -axis ( $y = 0$ ) is an *asymptote*
- **Domain**:  $(-\infty, \infty)$
- **Range**:  $(0, \infty)$

